The NOS Challenge

Thirty days of nature of science instruction for elementary students

By Cassie Quigley, Gayle Buck, and Valarie Akerson

"The picture of a scientist is me!" exclaims first grader Kendra during a nature of science (NOS) lesson. She drew a picture of a scientist and explained that she was going to be a scientist when she grew up because she "loved to observe like a scientist." Kendra's experience was a part of a 30-day unit designed specifically for first graders. During the lessons, Kendra and her classmates learned about NOS tenants through a variety of lessons and hands-on investigations. We were delighted to hear that Kendra and other students were inspired by this unit and were encouraged to become active participants in science. In this article, we outline the 30-day unit, provide journal prompts, and give examples of student's ideas through their quotes and journal entries. It is our hope that teachers will see the value and importance of teaching NOS aspects from an early age and take the NOS challenge!

Our 30-day unit included a 10-day decontextualized section that introduced the NOS aspects to the students and provided experiences for the students with these ideas. Then, we created a contextualized plant unit aligned to the national standards, which continued to focus on the NOS aspects. (See the NSTA Connection for a timeline describing the objectives, activities, and target NOS aspect of the unit.) The school described here is an all-girls school. Therefore the responses are from only girls. However, we have used this unit with standard classrooms composed of boys and girls with similar results.

What Research Says

Although researchers have long stressed the importantance of helping students develop an understanding of NOS to promote their scientific literacy, NOS instruction in many elementary schools often finds itself taught at the beginning of the year in Chapter One of the textbook, side-by-side with the steps of the scientific method. Researchers are still debating what understandings of NOS very young children can attain (Akerson and Donnelly 2010). But what the majority of research does demonstrate is that young children need explicit and reflective instruction to gain understanding of NOS aspects (Lederman 2007). We must explicitly draw out and direct students' attention to the ideas of NOS. Additionally, there needs to be a reflective time—including prompts—for students to reflect about the aspects as the students conduct their own scientific investigations. Although there is not one agreed-upon set of aspects of NOS, most standards focus on the following seven aspects:

- Tentativeness of Scientific Knowledge: Scientific knowledge is both tentative and reliable.
- Observation and Inferences: Science is based on both observations and inferences.
- Subjectivity: Science aims to be objective and precise, but as science is a human endeavor, subjectivity in science is unavoidable.
- Creativity: Scientific knowledge is created from human imaginations and logical reasoning. This creation is based on observations and inferences of the natural world. Scientists use their imagination and creativity throughout their scientific investigations.
- Social and Cultural Embeddedness in Science: Science is part of social and cultural traditions. People from all cultures contribute to science. As a human endeavor, science is influenced by the society and culture in which it is practiced.
- Scientific process based on empirical evidence: There is no single universal step-by-step scientific method that all scientists follow. Scientists investigate research questions with prior knowledge, perseverance, and creativity. Scientific knowledge is constructed and developed in a variety of ways including observation, analysis, speculation, library investigation, and experimentation.

The Challenge Begins

The first day began with a story selected to emphasize a NOS concept; a format that was followed throughout the remainder of the first part of the unit. This story was followed by a discussion of scientists and how scientists use journaling. Students drew pictures of scientists. The journals were used through the remainder of the unit.

Then, over the course of the next nine days, the learning experiences included various activities designed to explicitly introduce/reinforce NOS concepts. For example, students were asked to predict what was inside of the tube during the Think Tube activity (Lederman and Abd-El-Khalick 1998) by using their observational skills. The Think Tube is a white mail tube closed at both ends with four holes in it and strings attached in a variety of combinations so that when one end is pulled another end is pulled as well. The strings are secured with a washer in the middle for easy sliding. The students make inferences about how the strings are attached inside the tube based on their observations. Nakiyan inferred there was a rock inside the tube because of the sound the tube made when she shook it.

During the introductory unit, we provided the students with many opportunities to experience the empirical NOS (see NSTA Connection). Some of these lessons included collecting data through observations of living and nonliving things and making predictions of the growth of mealworms. Ebony demonstrated her ability to make observations and record those observations in her journal. She also made a prediction of what she thought would happen to the mealworm over the next couple of days. Leandria saw these observational moments as times when she was acting like a scientist.

Several of the girls described the subjective NOS when describing why scientists have different opinions as to why the dinosaurs are extinct. Anna simply stated, "We weren't there," and Tinaya said, "They wasn't born before when scientists were alive."

To begin Part 2, we held a full class review discussion of the NOS concepts, including questions such as "How were we acting like

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A plant unit emphasized the nature of science concepts.

Figure 1.

Journal prompts and corresponding nature of science aspects.

Day	Science Journal Topics	NOS Tenant
1	Draw a picture of the Nature of Me	Subjectivity
2	Draw a scientist	Creativity/subjectivity
2	Predict what is on the bottom of the cube.	Observation and inference
3	Based on your observations, what is inside the tube?	Observation and Inference
4	Categorize the items into living vs. nonliving things	Subjectivity
5	Draw your observations (before mealworm book) Then, draw your observations after reading the book	Observation and Inference Empirical
6	Draw your prediction of mealworms before seeing live ones Draw your observations of mealworms after seeing live ones	Observation and Inference Empirical
7	Draw observations of the fossils. Why did the dinosaurs die?	Observation and Inference Subjective Tentative
8	Draw your observations of oobleck	Observation and Inference Empirical Tentative
9	Draw what you think oobleck could be used for	Subjectivity
10	Floating vs. sinking Make predictions of which objects would float and which objects will sink. Draw your observations of which objects floated and which objects sank.	Empirical
11	How were you acting like a scientist today?	Observation and Inference Creativity

scientists last week?" The students made comments such as, "We acted like scientists when we observed." The focus of this unit was to address the standards on the living environment (plants) through NOS aspects. The first day of the unit began with the students drawing a plant and using that plant to lead a discussion on what they knew about plants, as well as questions they had about plants. This was followed by a discussion on which questions they could investigate and what those investigations would involve. The initial stages of inquiry into plants served to focus the remainder of part 2 of the unit. During that time, the students completed scientific observations of various plants and plant seeds, structured class inquiries on plant growth, as well as researched and completed structured inquiries on hydroponics and lima beans. The culminating learning experience was the completion of a semistructured investigation on peanut plants. We checked for peanut allergies before proceeding with this plant choice.

Throughout the unit, the concepts explored during the first part were often explicitly discussed in context of the plant inquiries. For example, the girls described the empirical NOS when they were writing in their journals about how they were acting like scientists when making predictions. The girls also described the specifics of making predictions and were able to do so. For example, Lelia predicted that her plant, which was in the closet, "will grow a little bit because it does not have any light except when we open the door to check it." Andrea stated, "It will not grow in a bag. We are not giving it air and not giving it space." Additionally, the girls created an investigation to discover what plants needed to grow. They created

Figure 2.

Journal prompts for plant unit with corresponding NOS aspects.

Day	Science Journal Topics	NOS aspect
12	What is a plant?	
12	What do plants need to grow?	Subjectivity
13	Design your experiment to test this idea of what plants need to grow.	Empirical nature of science
14–16	Make a prediction about which plant will grow the best. Make observations of the plants.	Observations Empirical nature of science
17	Make observations of the different types of seeds/plants	Observations
18	Make observations of the lima beans.	Observations
19	What do we need to grow peanuts?	Empirical nature of science

four investigations with controls and collected data on their plant growth. For example, when thinking how to control for sunlight, Layla said, "If we put it in the closet, it may not grow."

Also during this portion of the unit, we emphasized how science is socially and culturally embedded through examples of scientists such as George Washington Carver and Barbara McClintock. In these lessons, we described how these scientists' culture and social context influenced the way in which they conducted science and how they interpreted their results. For example, Barbara McClintock used observations based on her life experience to understand how corn kernels changed colors, which became the early foundation for genetics. We also emphasized how their culture helped to make these breakthroughs in science. Additionally, we focused on reading literature such as *Bringing the Rain to Kapiti Plain* (Aardema 1992) and how different cultures rely on different methods for growing plants.

Students recorded observations and predictions.

Using Science Journals

A major component of the unit was student's observations and data collection in their journals—personal records to help students in meaning-making. Using science journals in class can help students construct meaning of science content. We followed the advice of Hug, Krajcik, and Marx (2005) and used writing prompts to help students analyze and build explanations from evidence. Figure 1 (p. 59) describes the journal prompts for the decontextualized unit and corresponding NOS aspects. Figure 2 describes the journal prompts for the contextualized plant unit and corresponding NOS aspects. Often, due to the young age of the students, we would walk around to groups as they were working and write a description of what the students were drawing so that we could understand what they were thinking at the time of the journal entry. However, as the year progressed and their writing skills improved, the students transitioned to writing a verbal description of their picture. We found the journals helpful for formatively assessing the students and for understanding how their views of science were developing throughout the unit. The journals were used to check the progress of students' views and make adjustments to the lessons accordingly. For example, several students were mixing observations and infer-

ences after the Tricky Track lesson, so we revisited this concept. Tricky Tracks is a sequence of three pictures of two sets of tracks. The first picture shows the two sets of different tracks coming toward each other. In the second picture, the tracks meet in the middle and circle around one another. The last picture shows only one set of tracks leaving the circle. The students make observations first such as, "one set of marks is bigger than the other" and "there are more big marks than small marks." And then they make inferences such as, "there were two animals there and one flew away because there are two tracks at the beginning and one set of tracks at the end" or "The animals were there at different times and one smelled the scent of the other animal."

Conclusion

Overall, the 30 days of explicit and reflective NOS instruction helped the students to understand NOS aspects. For example, at the end of the unit, students were able to point to observations as a way to collect data and were able to differentiate between observations and inferences. Additionally, they were able to provide examples of how different scientists come to different conclusions. Moreover, we felt the use of writing prompts and the science journals to be an effective way to formatively assess their understandings of NOS aspects. We hope other teachers are encouraged to use these types of lessons in their classroom to promote NOS understandings even at a young age. ■

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Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Grades K–4

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry

Standard C: Life Science

- The characteristic of organisms
- Organisms and environments

Standard F: Science in Personal and Social Perspectives

- Changes in environments

Standard G: History and Nature of Science

- Science as a human endeavor

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NSTA Connection

Find a unit timeline with corresponding NOS aspects at *www.nsta.org/SC1110.*